Electricity is the basis of economic and technological development. It is one of the chief drivers of growth. Worldwide consumption of energy has been increasing rapidly due to growing population and rise in per capita consumption. But the reserves of energy resources in the earth's crust are limited and are gradually being exhausted. Thus a chronic imbalance between supply and demand has been developing for over many years. This explains why mankind is already confronted with the problem of replenishing its energy resources.

Energy can be classified into renewable(inexhaustible) and non-renewable (exhaustible) sources. Renewable energy sources are hydro, solar, wind, thermal, and tidal. The non-renewable energy sources are coal, petrol, natural gas, oil, geothermal steam hot water and nuclear fuel. While considering the renewable sources of electricity, it is important to note their reliability, cost and efficiency of converting the energy to electrical energy.

In India, options available for electricity generation include hydro, thermal, nuclear, tidal and renewable sources. A diversified energy resource base is essential for meeting the electricity requirements in the context of long-term energy security. Therefore it becomes mandatory to look for alternative sources of energy. Compared to all other sources of energy production, perhaps the nuclear power is the best source of energy. Uranium's availability at economically viable cost is a key factor that would allow a sharp expansion of nuclear power. Uranium has been called as nature's gift for clean economic development. In contrast, other fuels wastes are so large and unmanageable to be contained and are dispersed into the

environment causing pollution in environment. This is main difficulty that we are facing today in addition to provide clean, cheaper and reliable, electricity. Once nuclear power plant is commissioned, can help to reduce our exposure to hike price for operating and maintaining the process. Due to the advancement in nuclear technology the nuclear power industry is constructing a new generation of reactors of different types and capacities. Advanced nuclear reactors will also cost even less to operate and produce less waste. Due to improvement in nuclear technologies the innovation in nuclear technologies will be in incorporation of inherent or passive safety features, hence nuclear energy is the best option as India has large reserves of uranium and thorium.

During the fission reaction in nuclear power plant, number of fission products like ^{90}Sr, ^{137}Cs, ^{131}I, etc., are produced. Tritium(^{3}H) is radionuclide which is formed as an activation product by the neutron activation of deuterium of heavy water. ^{3}H is the major radionuclide released to the environment from nuclear power plants.

^{3}H, the heaviest and only radioactive isotope of hydrogen, has been a ubiquitous contaminant produced by PHWR's. The nuclide ^{3}H decays to form ^{3}He by emission of a beta particle with a maximum energy of 18 kev and an average energy of 5.7 Kev. It's radioactive half life is 12.3 years and biological half life is 6-10 days. ^{3}H is one of the most environmentally mobile radionuclide. Therefore, ^{3}H has a high potential for migration into the terrestrial environment by releases to the atmosphere from nuclear facilities. ^{3}H from nuclear facilities is released into the environment mainly as tritiated water (HTO). It rapidly enters the hydrological cycle and is ultimately incorporates into biological materials. The released ^{3}H undergoes dilution and dispersion and then follow the ecological pathway of water

molecule. Transfer of tritiated water from the atmosphere to the surface of the earth occurs mainly by precipitation and also by vapour exchange

The emission of ^{3}H from operating heavy water reactors are highly significant, because of its similarity with water in its physico-chemical properties, HTO(tritiated water vapour) gets incorporated in all environmental matrices such as soil, air and biota in the form of tissue free water tritium(TFWT) and organically bound tritium(OBT). TFWT means the HTO concentration in free water of the plant or animal tissue and OBT means the ^{3}H bonded to a carbon of the organic molecule of the plant or tissue. TFT and OBT have different characteristics. The TFT can be removed by simply washing the sample with water repeatedly for number of times, whereas OBT once formed is very difficult to remove because ^{3}H forms bond with carbon, nitrogen , sulpher of organic molecule of the plant or animal tissue.

In order to carry out the impact assessment due to ^{3}H, it is necessary to understand the kinetics of transfer of ^{3}H through various environmental matrices. The process of ^{3}H removal from the atmosphere is classified as wet deposition or dry deposition. When rain drops pass vertically through the tritiated plume, rain water scavenges ^{3}H from air due to the wash out process. Scavenging process operated by rain is one of the phenomena, which transfers the substances present in the atmosphere to the ground.

The dose due to ^{3}H release from nuclear facilities is of significance as ^{3}H released to the atmosphere attains equilibrium with the moisture in living organisms present in the matrix in which it is released. It is well known that ^{3}H oxide (HTO) enters the soil from the atmosphere by dry and wet deposition.

The process of wash out of ^{3}H due to precipitation is quite different as compared to other radionuclides like ^{90}Sr and ^{137}Cs. The rain scavenging of ^{3}H is a reversible process.

Kakrapar Atomic Power Station (KAPS), the fifth Pressurized Heavy Water Reactor (PHWR) is situated on the southern bank of Moticher lake, at Kakrapar, 85 km from Surat city, southern region of Gujarat State (Latitude-21^{o} 14' N and longitude-73 ^{o} 22' E). The plant has two units which became operational in 1992 and 1995 with the capacity is 220 MWe. KAPS 1&2 are Natural Uranium based reactors. Heavy water is used as a coolant and moderator. Two new units of KAPS (3&4) are pressurized water reactors which are under advance stage of construction with the capacity is 700 MWe.

The water requirement of the KAPS is met by Moticher lake. For the purpose of cooling and domestic use, KAPS draws 100 cusecs water from Moticher lake and discharges 75 cusecs through Blow down point. Due to continuous operation of KAPS, low level liquid waste is generated which is discharged through Blow down point into the Moticher Lake. The effluent gets diluted and after enormous dilution the water reaches to Ratania Regulator and through Ratania regulatator the water is regulated to different down stream locations of Jamankua, Vaduvania, Kadod, Bomaya. This water is mainly used for irrigation purpose in South Gujarat region. The low level liquid effluent which contains mainly ^{3}H is discharged into the lake. Besides this, ^{3}H is also released from KAPS to the atmosphere through stack following wind rose pattern. It reaches even to terrestrial environment. Hence it is very important to study ^{3}H activity in atmospheric, terrestrial and aquatic environment of KAPS.

FOCUS OF THE STUDY

Complete intensive study was conducted with the aim to monitor the tritium activity around KAPS environment. The study was carried out in atmospheric(with wind rose pattern), terrestrial, and aquatic environment analyzing air, water and biological samples (soil, rice, brinjal, papaya, sugarcane, fish, weed, silt). Simultaneously the dilution study for ^{3}H activity was conducted using grids for sampling from blow down point to 100 meters distance and extended upto 1.6 km.(exclusion zone) at ratania regulator. Collection and analyses of samples was done during 2009-2011.

In order to monitor the ^{3}H in atmospheric environment, the KAPS environment was divided into sixteen sectors and three zones. From all the sectors and zones atmospheric ^{3}H samples were colleted and analysed on monthly basis. Samples collected within plant premises (distance less than 1.6 km. from the plant) showed activity in between **≤0.20** Bq/m^3 (below detection level BDL)- 6.8 Bq/m^3 whereas of the samples beyond plant premise showed ^{3}H activity below detection level.

Terrestrial environment was divided into five zones and sixteen sectors with respect to aerial distance upto 30 km from KAPS. Different biological samples soil, rice, brinjal, papaya, sugarcane, were collected from four locations near KAPS Moticher, Jamankua, Kakrapar, and Ratania villages. All terrestrial samples were monitored for Tissue Free Tritium(TFT) and Organically Bound Tritium (OBT). Samples showed activity below detection level (BDL) **(≤7.0** Bq/Kg) fresh weight for TFWT and below detection level (BDL) **(≤300.0** Bq/Kg) dry weight for OBT.

In aquatic environment water samples from upstream to downstream and drinking water sources upto 30 km. distance were analysed. Weeds, silt, fish from Moticher lake were also analysed. The lake water showed ^{3}H activity

in the range of below detection level (BDL)-3579Bq/L. The highest ^{3}H activity was found from blow down point. The other water bodies like upstream downstream and drinking water sources showed activity below detection level (BDL) (**≤10Bq/L)**

For monitoring of dilution pattern of ^{3}H in Moticher lake various semicircular grids were made from the blow down point at various distance of 10, 20, 30, and 50 meters. Samples were collected from all the grid and farther downstream locations. Each sample was collected within 15 minutes time interval. Here an attempt was made to find out dilution of ^{3}H in Moticher lake. The average dilution factor for Moticher lake was around 100 at 1.6 km. from the blow down point.

The present study was overall mapping of ^{3}H around KAPS environment. Additionally, the study illustrated that the Kakrapar Atomic Power Station generates the electricity without any significant effluent discharge into the environment. The data presented in this research will be helpful to the Department of Atomic Energy as well as Veer Narmad South Gujarat University to demonstrate the distribution of ^{3}H around KAPS due to the operation of PHWR. Results would also give confidence to the residents of south Gujarat region about the operation of nuclear power plant.

Mohini Gadhia **Chetankumar P. Joshi**

(Supervising teacher) **(Candidate)**